

## **CLAIMS**

I claim:

1. A high efficiency switching amplifier for digitally processing electric power from a DC supply thereof to a loudspeaker, said switching amplifier comprising:
  - a voltage source for supplying a DC voltage,
  - a power modulator for transforming said DC voltage into modulated voltages,
  - a transformer for changing the amplitudes of said modulated voltages,
  - a synchronous demodulator for reconstructing said modulated voltages back to audio signal driving a loudspeaker,
  - a controller for receiving an audio signal to produce digital signals controlling the operation of said power modulator and said synchronous demodulator,  
wherein said controller controlling the timing of said power modulator to operate it in zero current switching.
2. A high efficiency switching amplifier comprising:
  - a transformer having a primary winding with a first terminal, a second terminal, a third terminal which is a primary center tap, and a secondary winding with a fourth terminal, a fifth terminal, and a sixth terminal which is a secondary center tap,
  - a power modulator comprising a first switch for selectively connecting said first and fourth terminals of said transformer to a ground reference, and a second switch for selectively connecting said second and fifth terminal of said transformer to said ground reference,
  - a voltage source connected between said third terminal and said ground reference,
  - a synchronous demodulator comprising four switches in a H-bridge configuration for selectively connecting said sixth terminal of said transformer to said ground reference through a load,
  - a controller for receiving an audio signal to produce digital signals controlling the operation of said power modulator and said synchronous demodulator,  
wherein said four switches of said H-bridge provide a bipolar signal to said load connected across said H-bridge, and wherein said controller controlling the timing of said power modulator to operate it in zero current switching.
3. A high efficiency switching amplifier comprising:
  - a transformer having a primary winding and a secondary winding having a first terminal, a second terminal, a third terminal which is a center tap, a voltage source connected to said primary winding of said transformer,
  - a power modulator for selectively connecting said primary winding of said transformer to a primary ground reference,

a synchronous demodulator comprising first and second switches for selectively connecting said first and second terminals of said transformer to a secondary ground reference, and four switches in a H-bridge configuration for selectively connecting said center tap of said transformer to said secondary ground reference via a load,

a controller for receiving an audio signal to produce digital signals controlling the operation of said power modulator and said synchronous demodulator,

wherein said four switches of said H-bridge provide a bipolar signal to said load connected across said H-bridge, and said wherein controller controlling the timing of said power modulator and said first and second switches of said synchronous demodulator to operate them in zero current switching.

4. The switching amplifier of claim 3 wherein said power modulator is a push-pull power switch.
5. The switching amplifier of claim 3 wherein said power modulator is a half-bridge power switch.
6. The switching amplifier of claim 3 wherein said power modulator is a full-bridge power switch.
7. A high efficiency switching amplifier comprising:
  - a transformer having a multiple-tap winding with a first terminal, a second terminal, a third terminal which is a center tap, a fourth terminal, and a fifth terminal,
  - a power modulator comprising first and second switches for selectively connecting said first and second terminals of said transformer to a ground reference,
  - a voltage source connected between said third terminal of said transformer and said ground reference,
  - a synchronous demodulator comprising a first and a second bi-directional switches having a common connection node and each connected in series with said fourth and fifth terminals of said transformer, and four switches in a H-bridge configuration for selectively connecting said common connection node of said first and second bi-directional switches to ground reference through a load,
  - a controller for receiving an audio signal to produce digital signals controlling the operation of said power modulator and said synchronous demodulator,
  - wherein said controller controlling the timing of said power modulator to operate it in zero current switching.
8. The switching amplifier of claim 7 wherein said synchronous demodulator comprises four bi-directional switches in a H-bridge configuration for selectively connecting said fourth and fifth terminals of said transformer to ground reference through a load.
9. The switching amplifier of claim 7 wherein said power modulator comprises additionally a third switch in series with said center tap of said transformer and wherein said four switches of said H-bridge are MOSFETs.

10. The switching amplifier of claim 8 wherein said transformer is an isolating transformer having a primary winding and a secondary winding, said secondary winding having a center tap.
11. The switching amplifier of claim 10 wherein said synchronous demodulator comprises four MOSFETs in a H-bridge configuration and a fifth MOSFET connected in series with said center tap.
12. The switching amplifier of claim 11 wherein said power modulator is a half-bridge power modulator.
13. The switching amplifier of claim 11 wherein said power modulator is a full-bridge power modulator.
14. The switching amplifier of claim 10 wherein said isolating transformer is split into two isolating transformers having windings connected in series.
15. The switching amplifier of claim 14 wherein two of said four switches in a H-bridge configuration are relocated to be connected to said ground reference.
16. The switching amplifier of claim 15 wherein said four switches are ground-referenced MOSFETs.
17. A high efficiency switching amplifier for digitally processing electric power from a DC supply to drive a loudspeaker isolated from the DC supply, said switching amplifier comprising:
  - a voltage source for supplying a DC voltage,
  - a power modulator for transforming said DC voltage into modulated voltages,
  - two transformers for changing the amplitudes of said modulated voltages, said two transformers having each a primary winding and a secondary winding, said two primary windings being connected in series,
  - a synchronous demodulator for reconstructing said modulated voltages back to audio signal driving a loudspeaker, said demodulator comprising four bi-directional switches selectively connecting said two secondary windings to a secondary ground reference isolated from said voltage source, through said loudspeaker,
  - a controller for receiving an audio signal to produce digital signals controlling the operation of said power modulator and said synchronous demodulator,
  - wherein said controller controlling the timing of said power modulator to operate it in zero current switching.
18. The switching amplifier of claim 17 wherein said four bi-directional switches of said synchronous demodulator are transistors.
19. The switching amplifier of claim 17 wherein said four bi-directional switches of said synchronous demodulator are four MOSFETs.
20. A method for reducing switching losses of a switching amplifier having a power modulator, a transformer, a synchronous demodulator, and a controller, said method comprising

adaptively sending timing signals to said power modulator, and after predetermined delays, sending timing signals to said synchronous demodulator, wherein said predetermined delays cause said power modulator to operate in zero current switching.